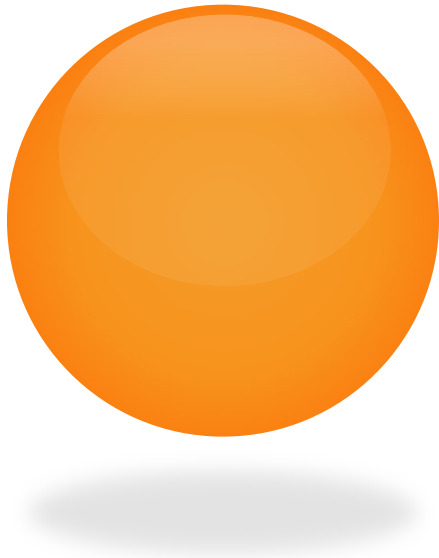




Jeff Arnold and the
Temple Conservation Assessment Team

SWAT watershed modeling

ceap wildlife



Watershed Modeling Background and Current CEAP Assessment

Model Philosophy

“Everything should be made as simple as possible. I have no interest in the laws of physics if they can't be made simple”

Albert Einstein

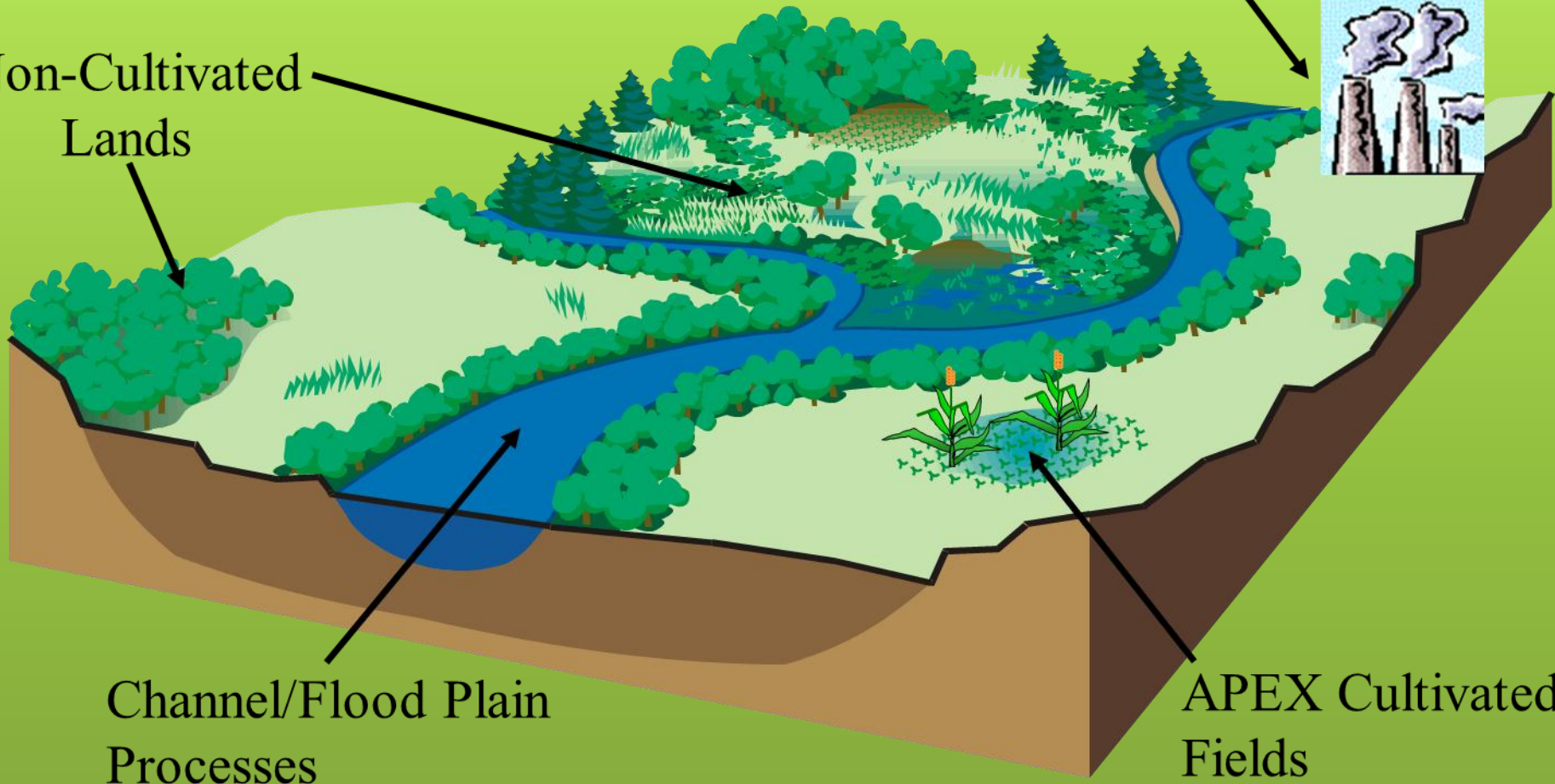
SWAT Watershed System for CEAP



Point Sources



Non-Cultivated
Lands



Channel/Flood Plain
Processes

APEX Cultivated
Fields

Model Processes

Processes are:

Interconnected

Impacted by Land Management and Climate

Impacted by Scale

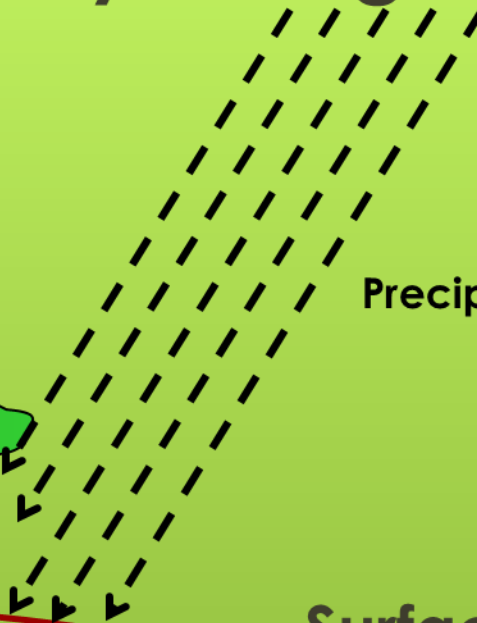
- Hydrology – Water Balance
- Erosion - Sedimentation
- Plant Growth
- Nutrient Fate and Cycling
- Carbon Balance
- Pathogens and Emerging Contaminants
- Flood Routing in Rivers and Reservoir Routing

Hydrologic Balance

Evaporation and Transpiration



Precipitation



Root Zone

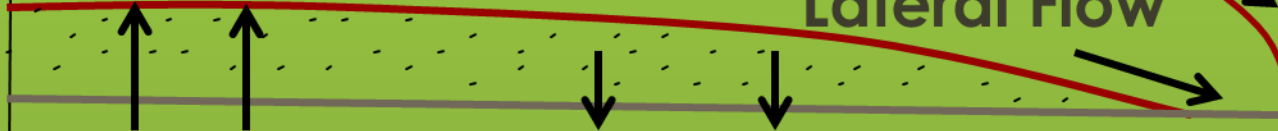
Infiltration/plant uptake/ Soil moisture redistribution



Surface Runoff



Lateral Flow



Return Flow



Vadose (unsaturated) Zone

Shallow (unconfined) Aquifer

Revap from shallow aquifer

Percolation to shallow aquifer

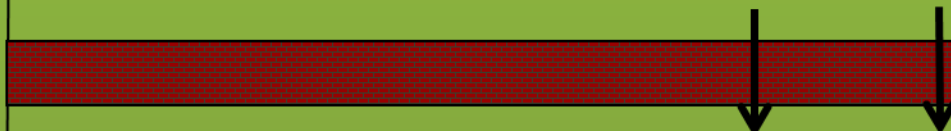


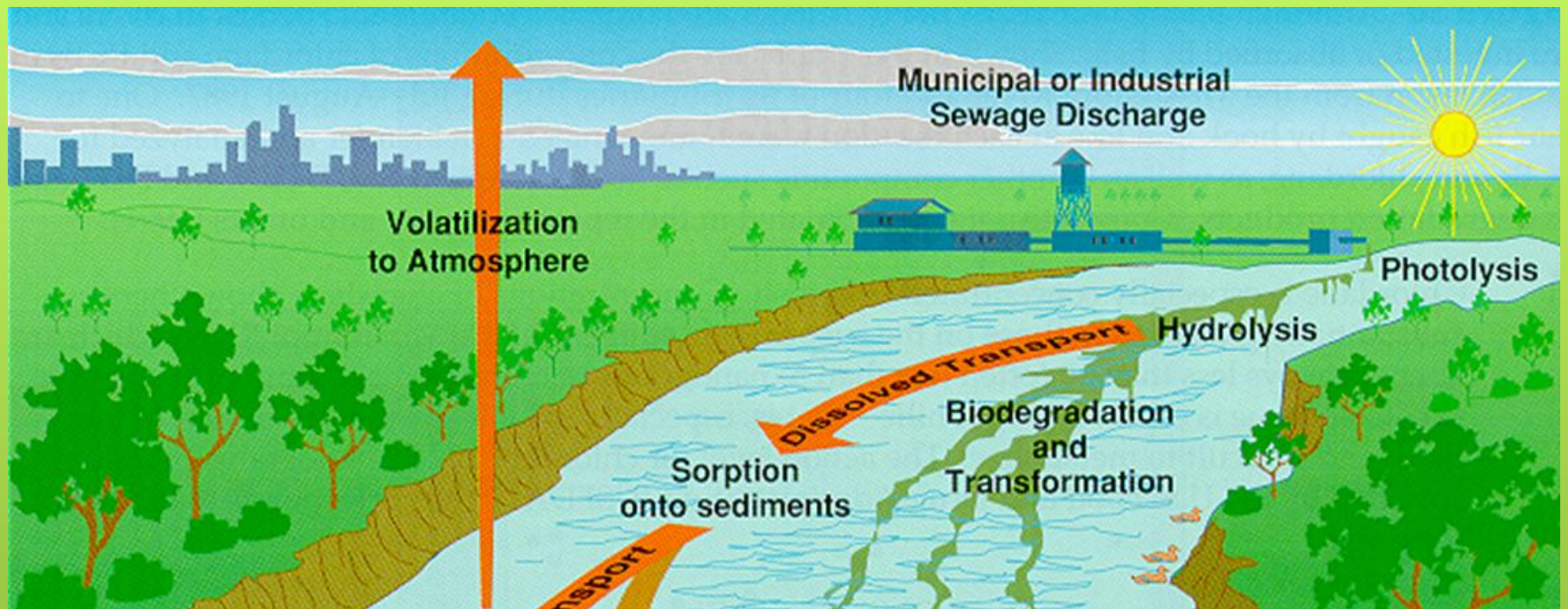
Confining Layer

Deep (confined) Aquifer

Flow out of watershed

Recharge to deep aquifer

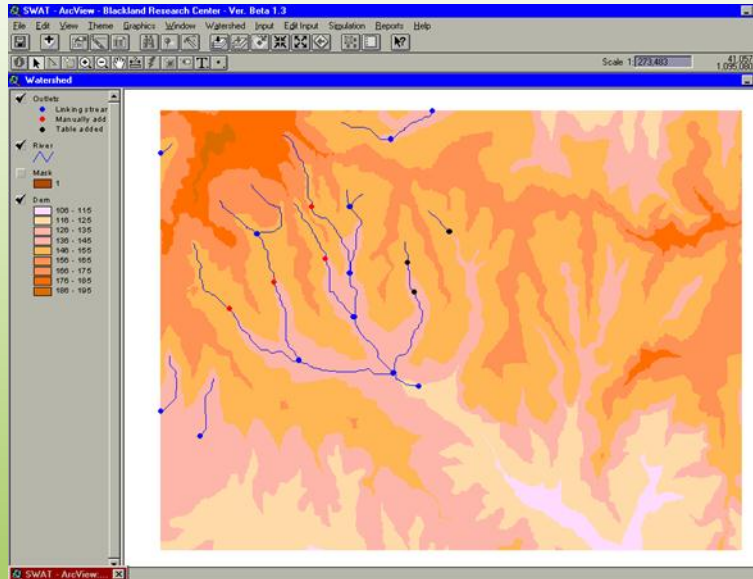




Channel Processes

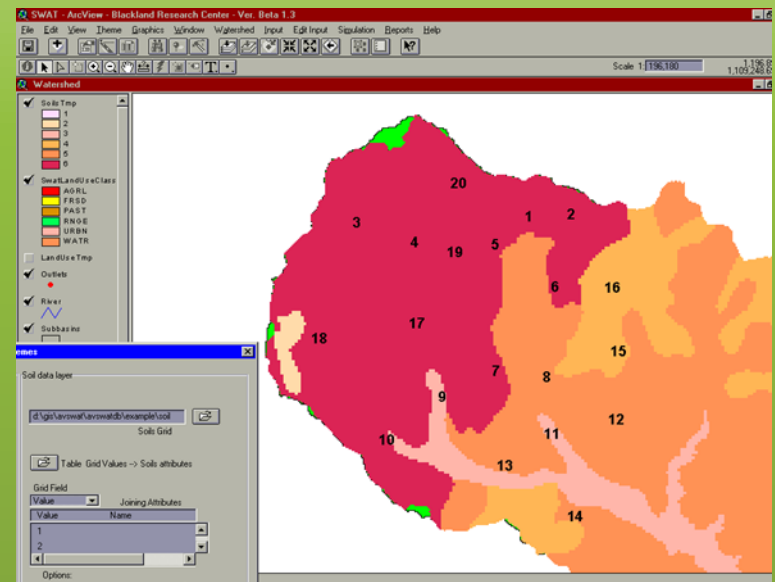
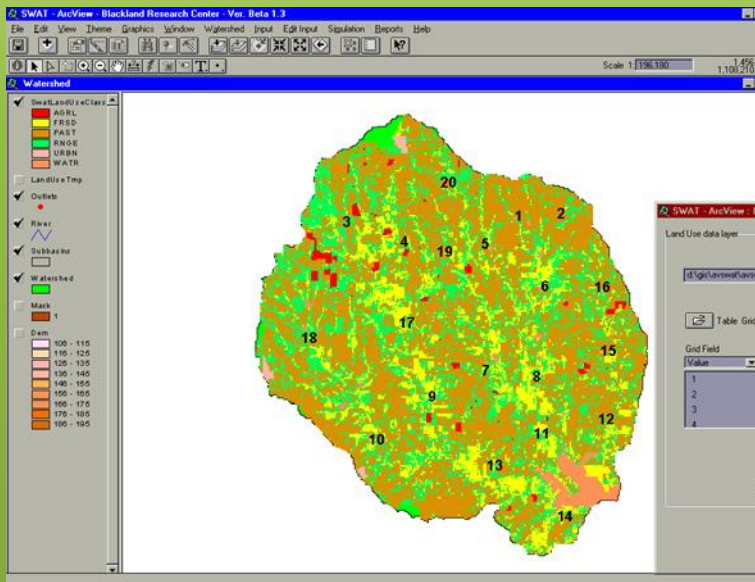
- Flood routing
- Transmission losses, evaporation
- Sediment routing, degradation, and deposition
- Nutrients – modified QUAL2E/WASP
- Pesticide – toxic balance

GIS Interface – Automate Inputs and Spatially Display Outputs



Weather

- Daily precipitation and max/min temp
- Monthly radiation, wind speed, humidity



Structural Management Practices Addressed by Model



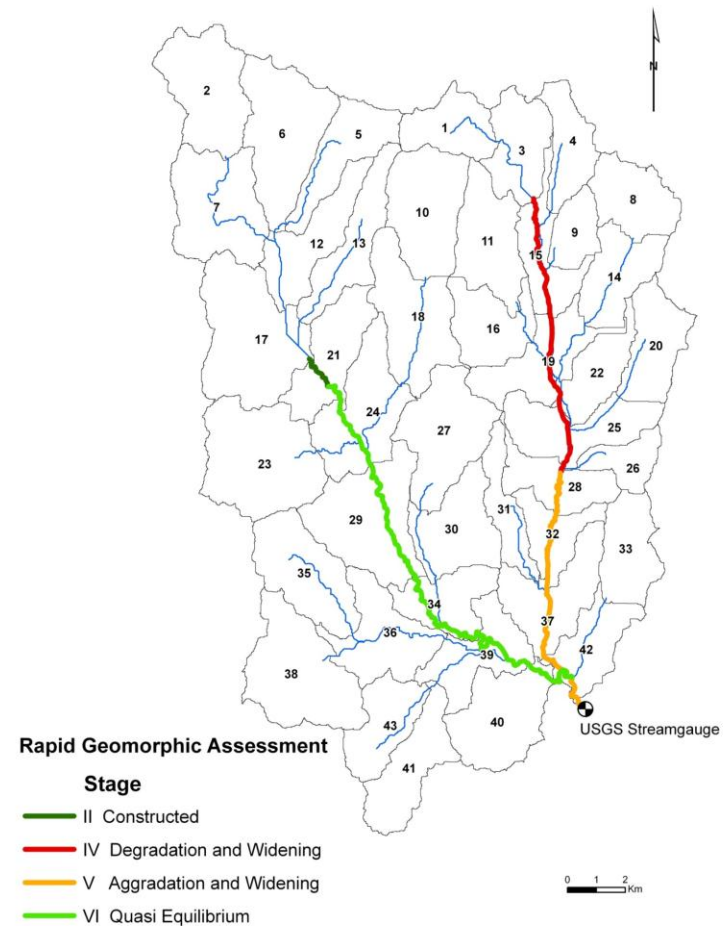
Nutrient Management Practices Addressed by Model

- Fertilizer and manure timing and application rates (impact of reducing nutrient inputs)
- Cropping systems – CRP, biofuel grasses, harvesting residue
- Pasture grazing and manure applications
- Tillage impacts – mixing residue and incorporating nutrients
- Point Sources
- Impoundments – wetlands to reservoirs



Model Outputs

- Time series (daily) at each subbasin outlet
 - Flow
 - Sediment
 - N and P
 - Pesticides
- Water balance
 - Sediment sources and sinks
 - N and P balances for each land use within the subbasin
- Plant biomass and crop yield





Cooperative State Research,
Education, and Extension Service
Research, Education, and Economics



Environmental Response

Measuring the Environmental Benefits of Conservation

The Conservation Effects Assessment Project (CEAP)

Why CEAP?

- OMB requests for outcome-based reporting
- 2002 Farm Bill
 - significant increase in conservation funding
 - call for better accountability
- Assessment to guide design and implementation of conservation programs



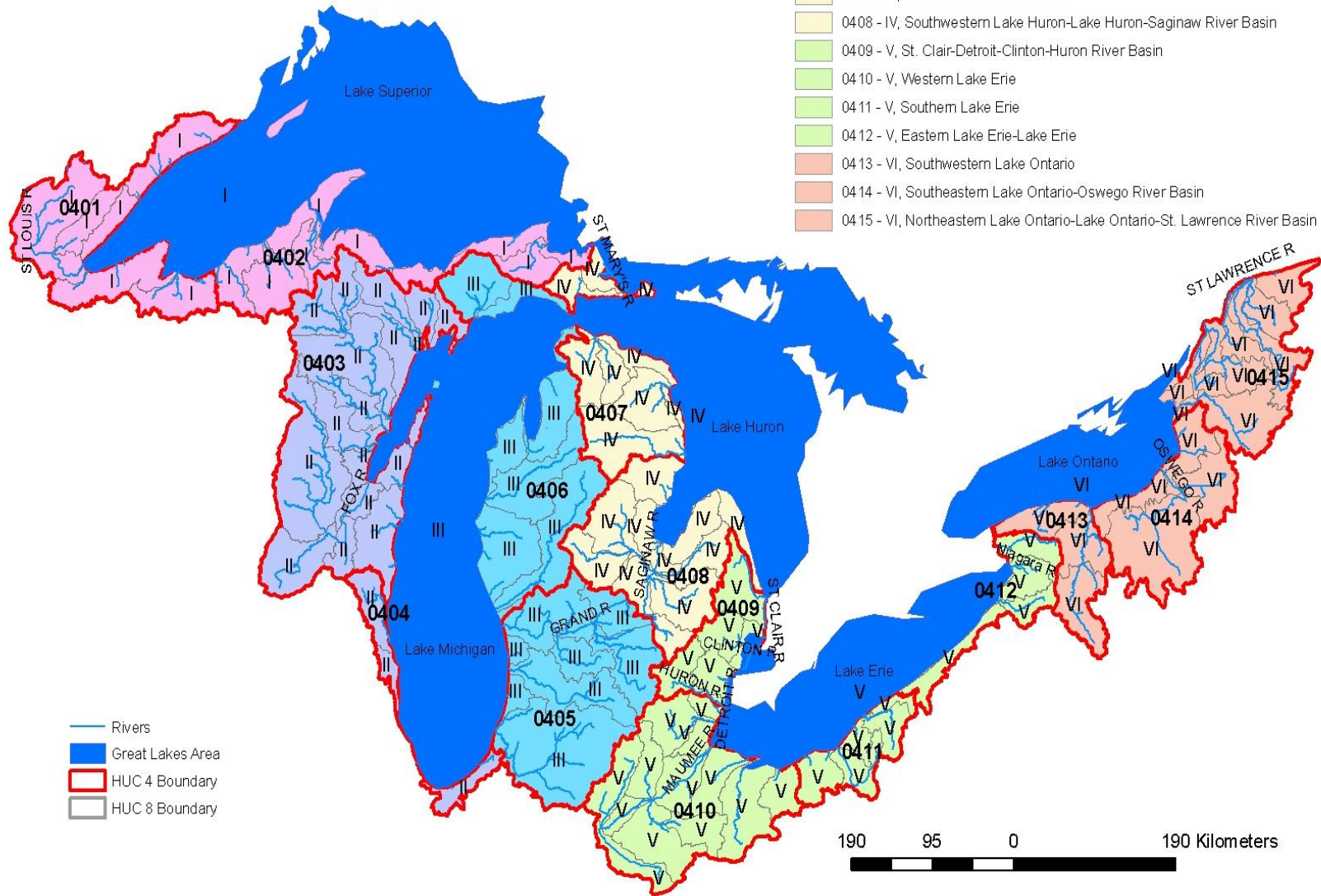
CEAP-Vision for the Future

- Vision: enhanced natural resources and ecosystems through:
 - more effective conservation
 - better management of agricultural landscapes
- Goal: improve efficacy of conservation practices and programs by providing the science and education base
 - conservation planning and implementation
 - management decisions
 - policy

Great Lakes Basin

Great Lakes HUCs

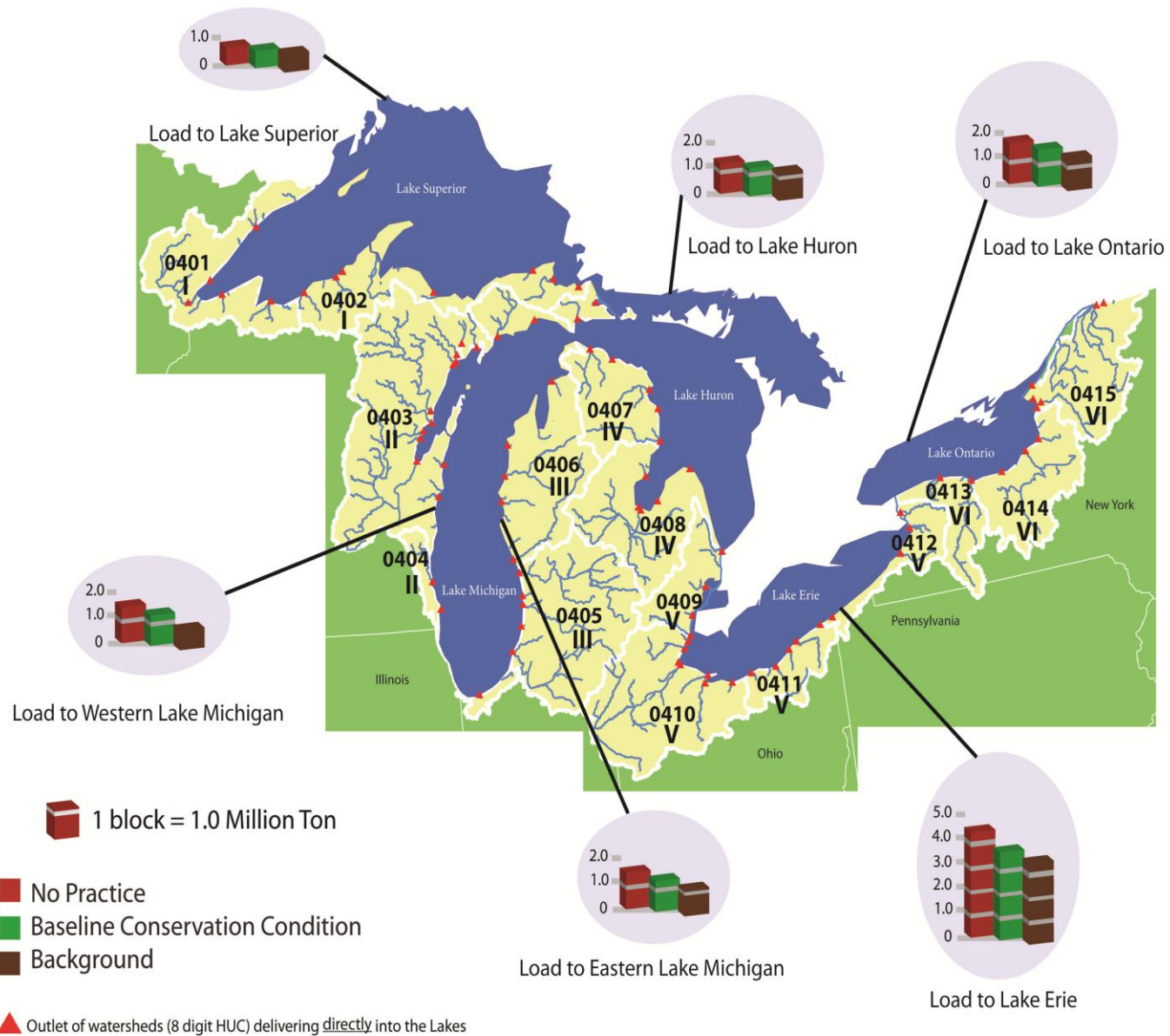
- 0401 - I, Northwestern-Southwestern Lake Superior-St. Louis River Basin
- 0402 - I, Southcentral-Southeastern Lake Superior-Lake Superior Basin
- 0403 - II, Northwestern Lake Michigan-Fox River Basin
- 0404 - II, Southwestern Lake Michigan
- 0405 - III, Southeastern Lake Michigan
- 0406 - III, Northeastern Lake Michigan-Lake Michigan
- 0407 - IV, Northwestern Lake Huron
- 0408 - IV, Southwestern Lake Huron-Lake Huron-Saginaw River Basin
- 0409 - V, St. Clair-Detroit-Clinton-Huron River Basin
- 0410 - V, Western Lake Erie
- 0411 - V, Southern Lake Erie
- 0412 - V, Eastern Lake Erie-Lake Erie
- 0413 - VI, Southwestern Lake Ontario
- 0414 - VI, Southeastern Lake Ontario-Oswego River Basin
- 0415 - VI, Northeastern Lake Ontario-Lake Ontario-St. Lawrence River Basin



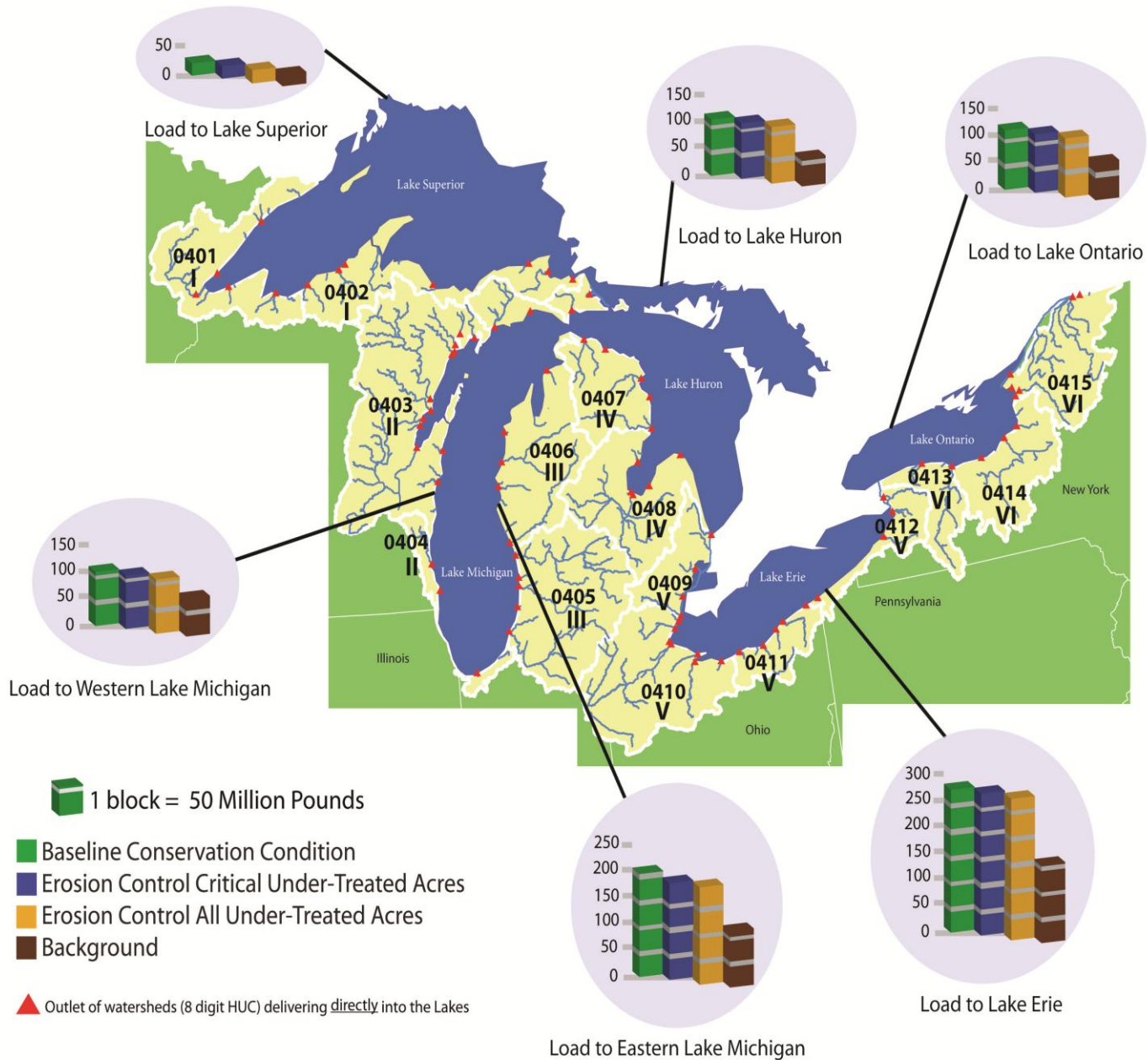
8-Digit Routing and Accumulation



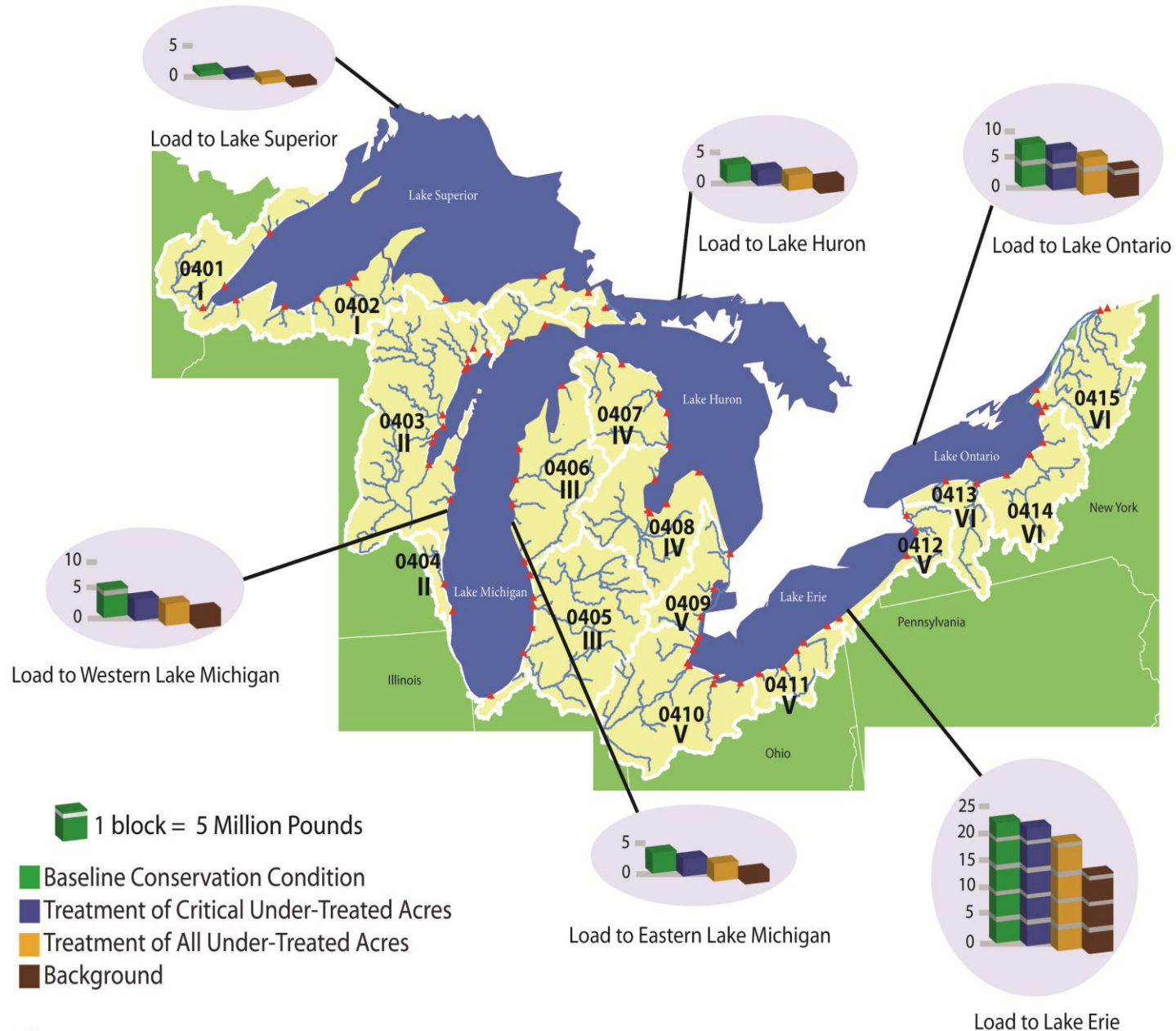
Sediment



Nitrogen



Phosphorus



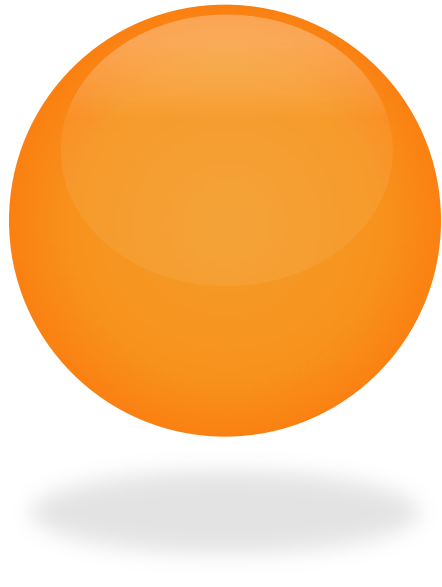
Comprehensive Planning is Needed

- Surface nitrogen losses reduced by 46 %, HOWEVER subsurface losses are reduced by only 5 %
- Without nutrient practices, erosion control practices can increase subsurface nitrogen losses



Targeting Conservation Increases its Impact

- 36 million acres (62%) are under-treated for sediment, nitrogen or phosphorus loss
- Treating 36 million acres of under-treated would cut nitrogen loss in subsurface flow from 21.8 to 11.4 lb/acre (48%); total nitrogen reduction of 43%; and total phosphorus reduction of 51%
- 8.5 million acres (15%) are critically under-treated for sediment, nitrogen or phosphorus loss
- Treating 8.5 million acres of critically under-treated would cut sediment loss from 1.0 to 0.6 t/acre (40%); nitrogen reduction from 8.6 to 6.1 lb/acre (29%); and phosphorus reduction from 3.0 to 2.4 lb/ha (22%)



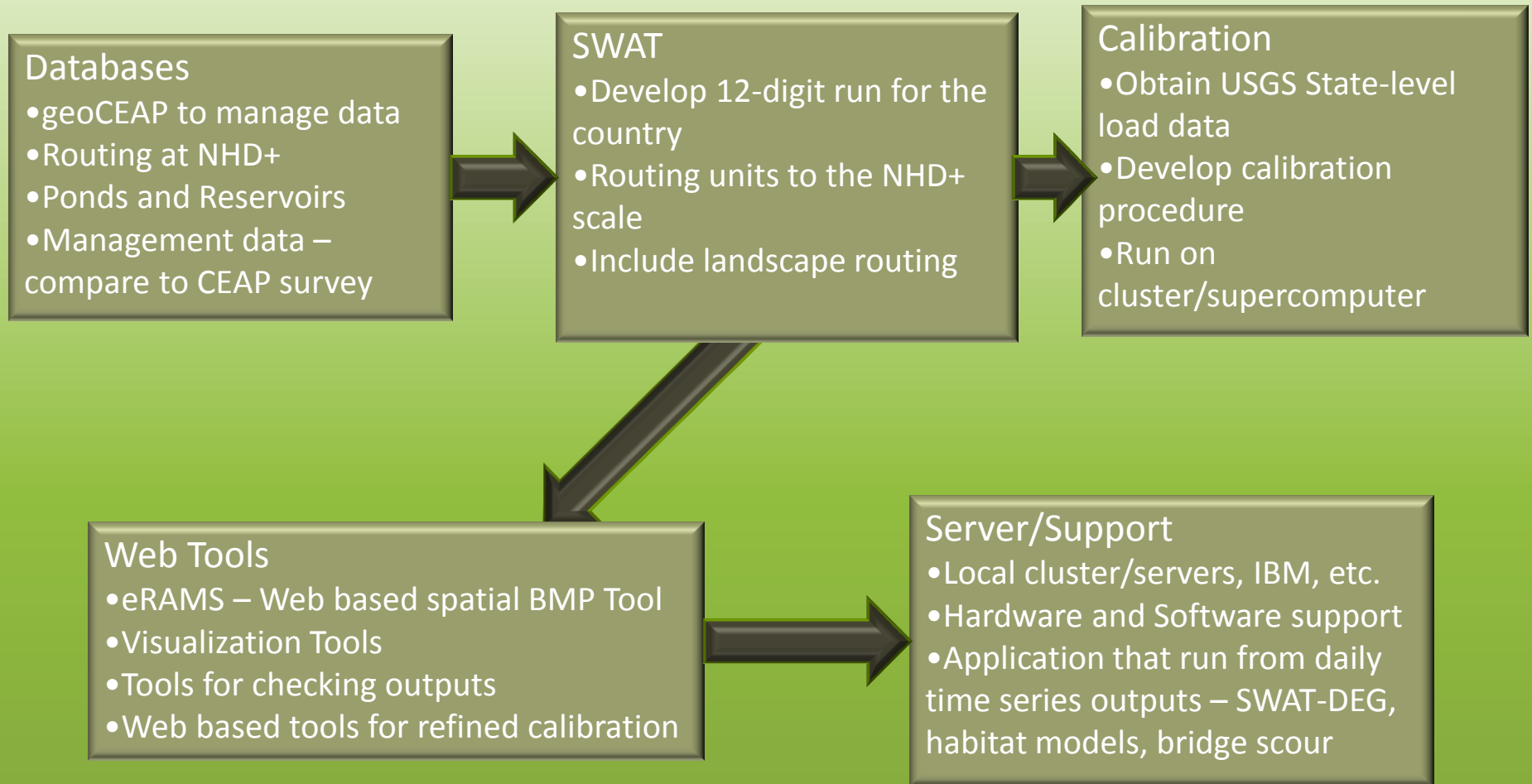
The future

Environmental Conservation on Landscapes for
Integrated Policy Scenarios

Environmental Conservation on Landscapes for Integrated Policy Scenarios

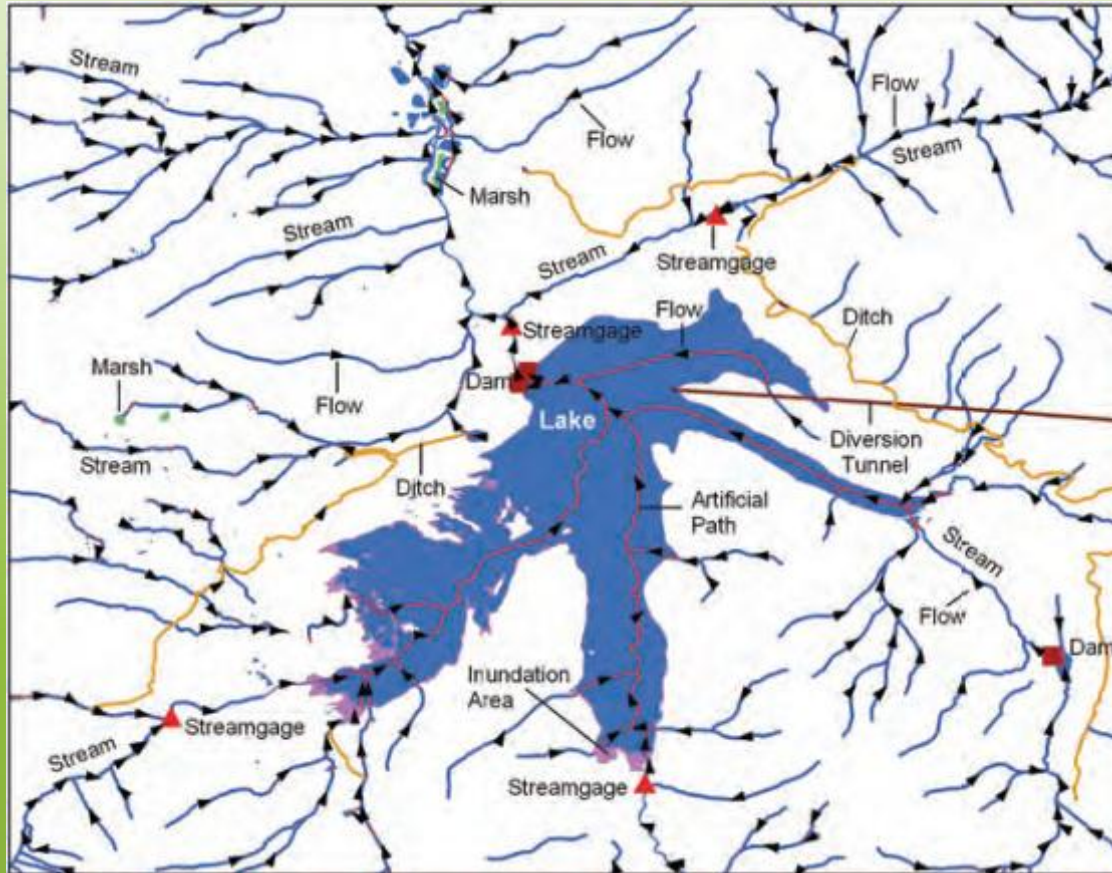
- Goal
 - Develop Regional/National “Pre-Calibrated” SWAT/APEX Simulations with a Web/Google Interface and Spatial BMP Tool for Scenario Analysis and Policy Planning
 - Pulls together CEAP, GeoCEAP, HAWQS, Calibration tools, Visualization and analysis tools, Optimization/Cost
- Outcome
 - Web-Based Decision Support System for Direct Use by Decision and Policy Makers

ECLIPS Structure



National Hydrography Dataset (NHD)

Set of digital spatial maps of lakes, ponds, streams, rivers, canals, stream gages, and dams



Watershed Boundary Dataset

Defines the perimeter of drainage areas formed by the terrain and other landscape characteristics

**Texas Gulf River Basin
(USGS #12)**



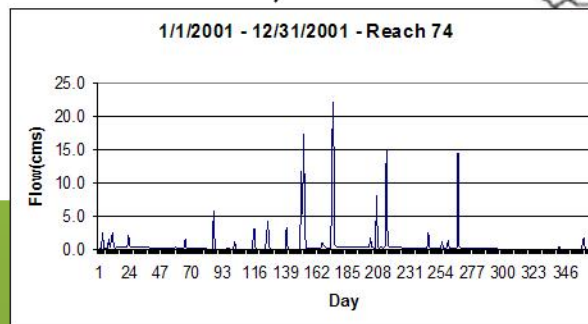
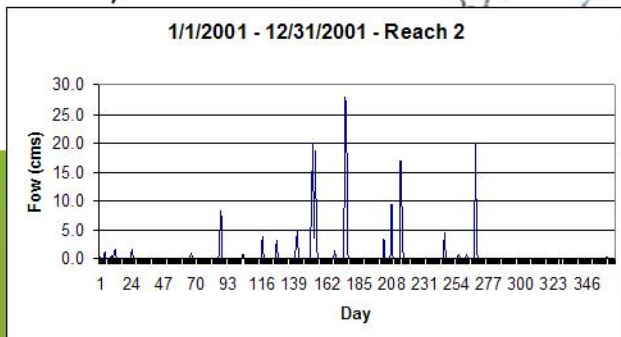
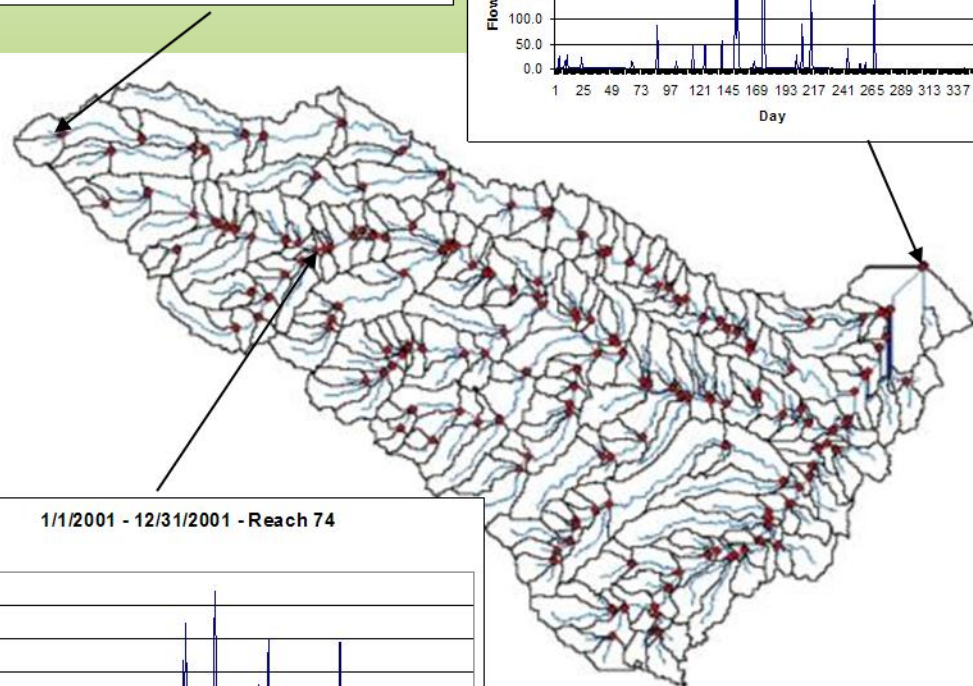
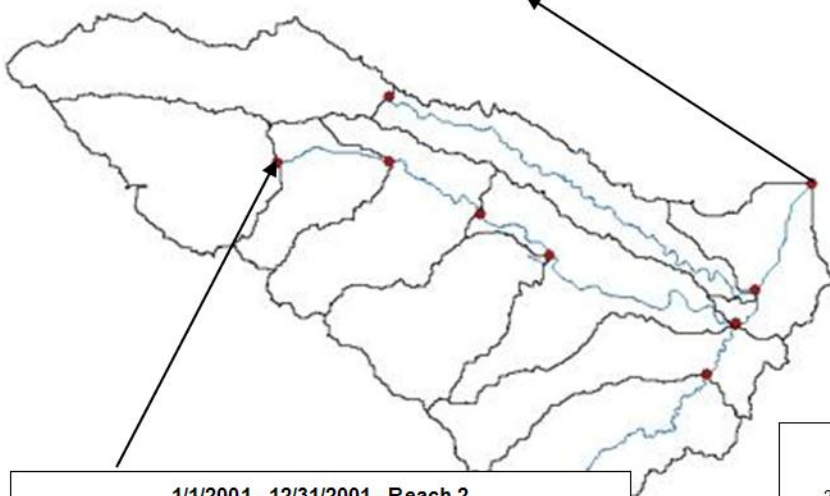
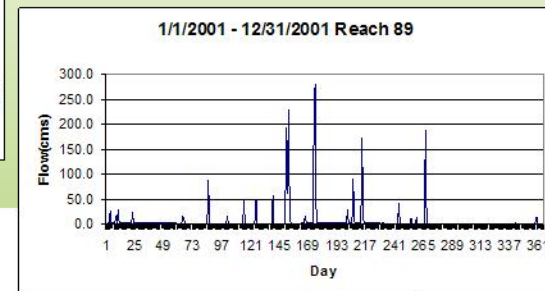
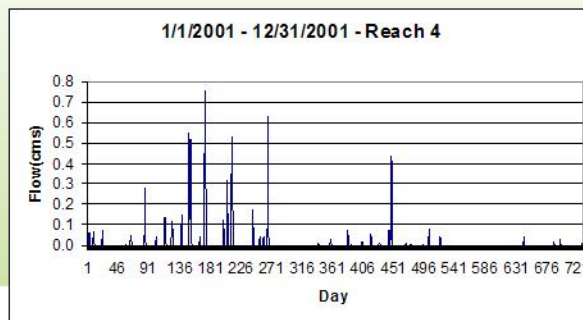
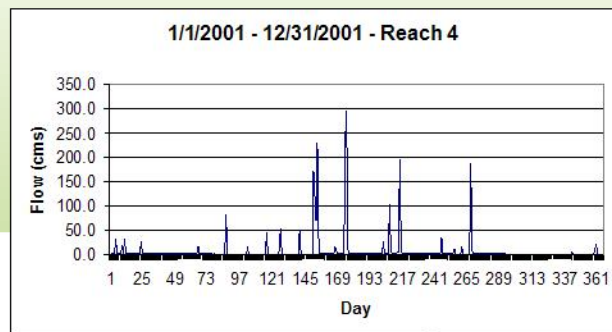
**Middle Bosque River
USGS 12060203 – 1092 km³**



**Willow Creek Subbasin
(USGS 120602030301 134 km²)**



**NHD+ Routing Units (43)
Average area = 3.1 km²**



Maumee River Basin

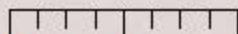
7 → 8-digit HUCs
252 → 12-digit HUCs

Michigan

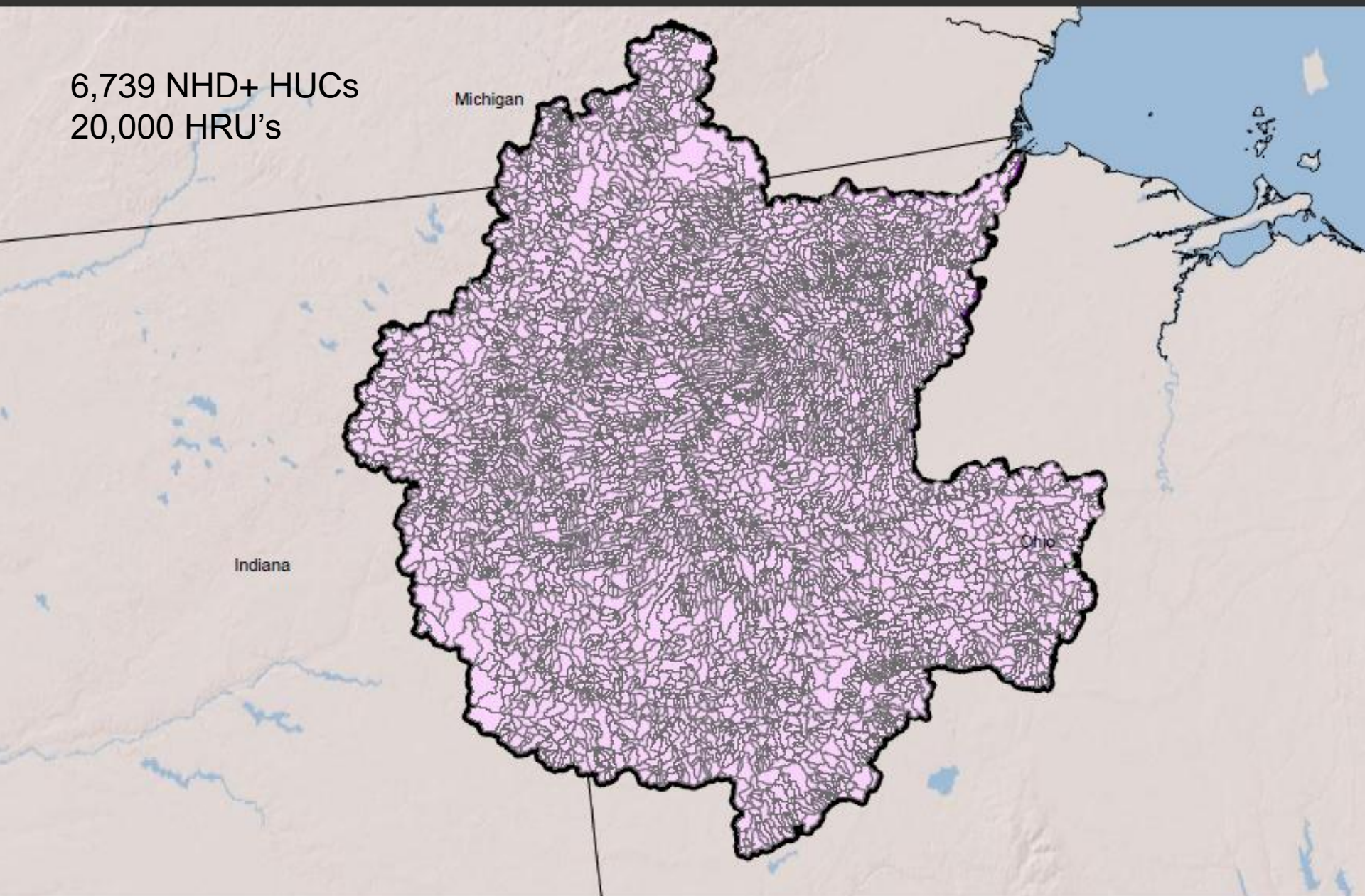
Indiana



- NHDplus
- huc12
- watershed boundary
- State boundaries



6,739 NHD+ HUCs
20,000 HRU's



Challenges and Opportunities

- ★ Sheer number of subbasins and HRUs. Increased storage and speed for calibration
 - Parallelize calibration runs
 - Parallelize input data and code
 - Routing units within 12-digits
- ★ Management data at NHD+ will be estimated from regional averages
- ★ Calibration data is only readily available at the 12-digit scale. USGS regional SPARROW models
- ★ Spatial data on reservoirs and point sources

Challenges and Opportunities

- ★ Linking with Wildlife model – thousands of stream nodes with daily hydrographs. Sheer numbers and mechanics of linkage
- ★ Linking with APEX – daily output from thousands of APEX output read into SWAT. Ultimately CEAP regional and national assessments will be on 12-digit and finer scales.
- ★ Web based results and interface. Ultimate goal is to present results in web and develop an interface to run scenarios

Major Opportunities

- ★ Report direct impact on wildlife - instead of kg or tons of load reduction.
- ★ Increased spatial resolution to answer local questions



Jeff Arnold and the
Temple Conservation Assessment Team

thank you

